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Vehicles and Plans

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National Aeronautics and Space Administration, Washington 25, D. C.
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ASTRONOMERS are understandably excited about the possibilities of making observations from beyond the terrestrial atmosphere. At the present time, astronomical observations are limited to the relatively small visual window, the somewhat more broken near-infrared region, and a broader, more newly exploited radio region. This means that many important astronomical data are hidden. For example, the solar corona emits strongly in the ultraviolet and in the long-wave region. The disturbed sun flares strongly in Lyman-Alpha and in low radio frequencies. Emission nebulae are bright in Lyman-Alpha and in high radio frequencies. Planetary radiations reach a maximum in the far infrared where they are now masked by the terrestrial atmosphere. Very hot stars are bright in the ultraviolet; interstellar dust should shine by its own emission in the far infrared. Finally, in distant galaxies, we now see only the portion of the spectra which for the nearer galaxies is in the hidden ultraviolet region of the spectrum. Observations of the distant and near galaxies in comparable spectral regions will permit a study of possible galactic aging effects. For all of these objects, and many others, we anticipate that observations in the now hidden spectral regions will be of great interest and great importance to the future of astrophysical development.

Of the vehicles which have been used to place American satellites in orbit, the Jupiter C, the Juno II, and the Vanguard will soon be replaced by systems more specifically designed for space research. The first of these will be the Delta and the Scout. The Delta will be used in about a year for an Orbiting Solar Observatory, a satellite weighing approximately 350 lb with a stabilization system designed to permit the continual accurate pointing of optical equipment to the solar disk. The Scout will permit the orbiting of somewhat smaller payloads and will be particularly useful for high altitude rockets and for low altitude, monitoring satellites. Later the Delta will be replaced by the Agena B boosted by either a Thor or an Atlas. The latter will be used to place multi-ton payloads in earth orbits and usable payloads near the moon. The Centaur, Saturn, and Nova will provide successively larger payloads at increasing distances from the earth.

The ultimate aim of the Lunar Science Program is to place a manned scientific station on the moon. In the meantime, we hope to learn as much as possible about the lunar atmosphere, surface, and interior from lunar orbiters, impacts, and hard and soft landings. The lunar surface will be mapped spectrophotometrically by a radar altimeter and by vidicon; the surface composition

will be analyzed by gamma-ray spectrometry and tested for natural beta and gamma-radioactivity, and surface hardness will be determined by a penetrometer. Instrumentation for studying the lunar environment will make measurements of the density, ionization, and the magnetic field in the lunar atmosphere, the plasma density and temperature of the lunar ionosphere, soft and energetic particles fluxes, and cosmic radiation and micrometeorites. Some of the early experiments which are being prepared are a rubidium-vapor magnetometer, a plasma probe, a seismograph, a penetrometer, and a radiation complex to measure cosmic radiation in the vicinity of the moon.

The aim of the NASA Solar Physics Program is to obtain an understanding of the solar atmosphere and of the solar-planetary relationships by studies from earth satellites in the ultraviolet, x-ray, gamma-ray, and radio region of the spectra, and by probe instrumentation to measure the composition of the solar atmosphere and eventually atmospheric activity on other planets. The Orbiting Solar Observatory is mentioned above. This Observatory will carry ultraviolet spectrographs, ultraviolet and x-ray photometers, a gamma-ray telescope, and other equipment for measuring solar and geophysical quantities. Instrumentation for a later version of the solar observatory is expected to include a coronagraph, a spectroheliograph, and other equipment for studying the sun in greater detail than will be possible from the first solar satellite.

The Observational Astronomy Program includes five projects. The largest is the Orbiting Astronomical Observatories Project, in which a satellite containing a moderately large optical telescope is planned. Satellite stabilization and guidance will permit tracking a star or star field within a small fraction of a second of arc. This project will be discussed in greater detail in other papers in this symposium. However, important features should be mentioned. The satellite can have a large primary mirror for spectroscopy and/or smaller objectives for photometry and mapping in various regions of the spectrum. A finder telescope system will permit the identification of the star field under observation from the earth; an independent system for determining the orientation of the telescope objective in space will be provided as well. Solar cells will provide power for the vehicle through its lifetime of at least one year. Of course, antennas to transmit the large amount of information obtained back to the terrestrial tracking and data centers will be needed.

There are four other projects in the Observational

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Astronomy Program. The first of the astronomical satellite launchings will occur sometime later this year in the Gamma-Ray Astronomy Project. This satellite will be launched by a Juno II and will be instrumented to measure the spatial distribution of 100-mev gamma-ray radiation. Later experiments will provide increased sensitivity and finer energy and spatial resolution for photometry, mapping and monitoring in the gamma-ray region.

In the orbiting Radio Astronomy Project, instrumentation is currently being developed for measuring the cosmic noise background in the region normally reflected by the terrestrial atmosphere, that is, between 0.2 and 20 Mc. Later we hope that this project will also include instrumentation to bridge the present gap between radio and optical astronomy by making possible observations in the wavelengths shorter than 4 mm. Far-infrared observations are contemplated in the Orbiting Astronomical Observatories Project.

The Relativity Investigations Project includes an atomic clock experiment on which work is well underway, a satellite to monitor the earth's gravitational field for secular and periodic changes, and an artificial planet carrying a radar transponder to measure more accu-

ately the size and shape of the earth's and the planetoid's orbits.

Finally, the Advanced Galactic Investigations Project includes astronomical plans for the future which have not yet been implemented. This will include, for both the solar and the galactic investigations, advanced orbiting optical and radio instrumentation, instrumentation on the moon, and finally in the distant future, manned lunar observatories.

A fundamental part of all of these plans is the participation of the entire astronomical community. NASA will act as a coordinating agency to enable astronomers to obtain the basic observations they need from outer space. Each of the remaining speakers in this symposium is participating in this program. Other institutions cooperating in the NASA Astronomy Programs include the National Bureau of Standards, the Army Ballistic Missile Agency, the Massachusetts Institute of Technology, California Institute of Technology, Columbia University, the Universities of Rochester, Colorado, Arizona, New Mexico, and Chicago, Kitt Peak National Observatory, and NASA's Goddard Space Flight Center. In addition, much of the engineering and construction will be done by industrial contractors.